INTRINSIC: Parameter-Free Private Keystroke Classification With Normalized Relative Compression

Westemeier, Huxley (School: Saint Paul Academy and Summit School)

Passwords are failing. Stolen credentials are now responsible for over 88% of online attacks, and systems are unable to detect when an attacker bypasses a login screen or accesses an unattended physical device. One solution is keystroke dynamics, which continuously verifies each user's unique typing rhythm. However, the computational demands of existing classifiers make them highly impractical for background authentication. I created INTRINSIC, an approach that eliminates overhead by replacing machine learning with Normalized Relative Compression, the principle that similar pieces of data compress well together, while disparate ones do not. INTRINSIC maps raw keystrokes destructively to four-character tokens, which are processed by Prediction by Partial Matching (PPM) models to learn how a person types across multiple context lengths. Authentication samples are first compressed against stored candidate models to generate rankings and confidence scores, and then the order is reversed to see how efficiently the sample's PPM model compresses the candidate's data. Genuine matches compress efficiently in both directions, while impostors do not. When INTRINSIC was evaluated on password-entry samples from KeyRecs, a 99-user, 1.6-million-keystroke dataset, it outperformed existing classifiers in terms of Equal Error Rate (2.96% vs 10.06%) and processed samples in only 18.4 milliseconds without a GPU. On free-text samples, INTRINSIC achieved 94.44% accuracy (AUC=0.99, EER=2.72%), which increased to 99.55% when confident. INTRINSIC also reached 93.99% accuracy at recognizing the authors of 100 Project Gutenberg texts, demonstrating that it can generalize to broader identification tasks.

Awards Won:
Second Award of $2,400
Midwest Microelectronics Consortium: Four cash awards of $3,000 each.
Association for the Advancement of Artificial Intelligence: AAAI Membership for the School Libraries of All 8 Winners (in-kind award / part of 1st-3rd prize and honorable mentions' prize)